

WHAT IS CLAIMED IS:

1. An optical transmission system, comprising:
 - one or more first light sources for Raman amplification that amplify signal light transmitting in an optical transmission line; and
 - one or more second light sources for Raman amplification
- 5 that are disposed at the positions adjoining said one or more first light sources for Raman amplification via said optical transmission line, wherein:
 - each of said one or more first light sources for Raman amplification, comprising:
 - 10 a first pumping light source that emits first pumping light at a normal time as a pumping light source; and
 - a first optical multiplexer that inputs said first pumping light to said optical transmission line, and
 - each of said one or more second light sources for Raman
 - 15 amplification, comprising:
 - a second pumping light source that emits second pumping light of the same wavelength band of said first pumping light at a normal time as a pumping light source;
 - a spare pumping light source that emits spare pumping light
 - 20 of the same wavelength band of said first pumping light based on necessity;
 - an optical coupler that couples said second pumping light and said spare pumping light; and
 - a second optical multiplexer that inputs said coupled
 - 25 pumping light to said optical transmission line, wherein:
 - in case that a failure occurred at said first or second pumping light source, said spare pumping light source is worked and said spare pumping light is emitted.

2. An optical transmission system, comprising:

one or more first light sources for Raman amplification that amplify signal light transmitting in an optical transmission line; and

one or more second light sources for Raman amplification
5 that are disposed at the positions adjoining said one or more first light sources for Raman amplification via said optical transmission line, wherein:

each of said one or more first light sources for Raman amplification, comprising:

10 plural first pumping light sources that emit plural first pumping light whose wavelengths are different from each other at a normal time, as pumping light sources;

a first optical multiplexer that multiplexes said plural first pumping light; and

15 a second optical multiplexer that inputs said multiplexed first pumping light to said optical transmission line, and

each of said one or more second light sources for Raman amplification, comprising:

plural second pumping light sources that emit plural second
20 pumping light whose wavelengths are the same ones corresponding to said plural first pumping light sources at a normal time, as pumping light sources;

plural spare pumping light sources that emit plural spare pumping light whose wavelengths are the same ones corresponding to
25 said plural second pumping light sources based on necessity;

plural optical couplers that couple said second pumping light and said spare pumping light of the same wavelength band;

a third optical multiplexer that multiplexes plural coupled pumping light whose wavelengths are different from each other; and

30 a fourth optical multiplexer that inputs multiplexed

pumping light to said optical transmission line, wherein:

in case that a failure occurred at one in said plural first or plural second pumping light sources, said spare pumping light source whose wavelength band is the same one that said failure occurred is
35 worked and said spare pumping light is emitted.

3. An optical transmission system in accordance with claim 1, wherein:

in case that a failure occurred at said first or second pumping light source, said spare pumping light is emitted from said
5 spare pumping light source so that the output level of said signal light becomes the same output level before said failure occurred.

4. An optical transmission system in accordance with claim 2, wherein:

in case that a failure occurred at one in said plural first or plural second pumping light sources, said spare pumping light is
5 emitted from corresponding one of said plural spare pumping light sources so that the output level of said signal light becomes the same output level before said failure occurred.

5. An optical transmission system in accordance with claim 1, wherein:

in case that a failure occurred at said first or second pumping light source, said spare pumping light is emitted from said
5 spare pumping light source so that the gain wavelength characteristic of said signal light becomes the same gain wavelength characteristic before said failure occurred.

6. An optical transmission system in accordance with claim

2, wherein:

in case that a failure occurred at one in said plural first or plural second pumping light sources, said spare pumping light is
 5 emitted from corresponding one of said plural spare pumping light sources so that the gain wavelength characteristic of said signal light becomes the same gain wavelength characteristic before said failure occurred.

7. An optical transmission system in accordance with claim 1, wherein:

each of said one or more first light sources for Raman amplification, further comprising:

5 a control circuit that controls said first pumping light source, and

each of said one or more second light sources for Raman amplification, further comprising:

a control circuit that controls said second pumping light
 10 source and said spare pumping light source.

8. An optical transmission system in accordance with claim 2, wherein:

each of said one or more first light sources for Raman amplification, further comprising:

5 a control circuit that controls said plural first pumping light sources; and

each of said one or more second light sources for Raman amplification, further comprising:

a control circuit that controls said plural second pumping
 10 light sources and said plural spare pumping light sources.

9. An optical transmission system, comprising:

one or more light sources for Raman amplification not having a redundancy system that amplify signal light transmitting in plural optical transmission lines; and

5 one or more light sources for Raman amplification having a redundancy system that are disposed at the positions adjoining said one or more light sources for Raman amplification not having said redundancy system via said plural optical transmission lines, wherein:

each of said one or more light sources for Raman
10 amplification not having said redundancy system, comprising:

plural first pumping light sources that emit first pumping light whose wavelengths are different from each other at a normal time, as pumping light sources;

a first means that multiplexes said plural first pumping
15 light and splits multiplexed pumping light into plural pumping light; and

plural first optical multiplexers that input split pumping light to said plural optical transmission lines, and

each of said one or more light sources for Raman
20 amplification having said redundancy system, comprising:

plural second pumping light sources that emit second pumping light whose wavelengths are the same ones of said plural first pumping light sources at a normal time, as pumping light sources;

25 plural spare pumping light sources that emit spare pumping light whose wavelength bands are the same ones corresponding to said plural first pumping light sources, based on necessity;

plural optical couplers that couple said second pumping light and said spare pumping light of the same wavelength band;

30 a second means that multiplexes plural coupled pumping

light whose wavelengths are different from each other and splits multiplexed pumping light into plural pumping light; and

plural second optical multiplexers that input split pumping light to said plural optical transmission lines, wherein:

35 in case that a failure occurred at one in said plural first pumping light sources in said one or more light sources for Raman amplification not having said redundancy system or at one in said plural second pumping light sources in said light sources for Raman amplification having said redundancy system, said spare pumping
40 light source whose wavelength band is the same one that said failure occurred is worked and said spare pumping light is emitted.

10. An optical transmission system, comprising:

one or more light sources for Raman amplification not having a redundancy system that amplify signal light transmitting in plural optical transmission lines; and

5 one or more light sources for Raman amplification having a redundancy system that are disposed at the positions adjoining said one or more light sources for Raman amplification not having said redundancy system via said plural optical transmission lines, wherein:

10 each of said one or more light sources for Raman amplification not having said redundancy system, comprising:

plural first pumping light sources that emit first pumping light whose wavelengths are different from each other at a normal time, as pumping light sources;

15 a first means that multiplexes said plural first pumping light and splits multiplexed pumping light into plural pumping light; and

plural first optical multiplexers that input split pumping light to said plural optical transmission lines, and

each of said one or more light sources for Raman
20 amplification having said redundancy system, comprising:

plural second pumping light sources that emit second
pumping light whose wavelengths are the same ones of said plural
first pumping light sources at a normal time, as pumping light
sources;

25 plural spare pumping light sources that emit spare pumping
light whose wavelength bands are the same ones corresponding to said
plural first pumping light sources, based on necessity;

plural optical multiplexers that multiplex said second
pumping light having different wavelengths in one of said plural
30 optical multiplexers and multiplex said spare pumping light having
different wavelengths in other of said plural optical multiplexers;

a second means that multiplexes plural multiplexed
pumping light whose wavelengths are different from each other and
splits multiplexed pumping light into plural pumping light; and

35 plural second optical multiplexers that input split pumping
light to said plural optical transmission lines, wherein:

in case that a failure occurred at one in said plural first
pumping light sources in said one or more light sources for Raman
amplification not having said redundancy system or at one in said
40 plural second pumping light sources in said light sources for Raman
amplification having said redundancy system, said spare pumping
light source whose wavelength band is the same one that said failure
occurred is worked and said spare pumping light is emitted.

11. An optical amplification method in an optical
transmission system, in which one or more first light sources for
Raman amplification that amplify signal light transmitting in an
optical transmission line and one or more second light sources for

5 Raman amplification that are disposed at the positions adjoining said one or more first light sources for Raman amplification via said optical transmission line are provided, comprising the steps of:

amplifying said signal light by said one or more first and second light sources for Raman amplification;

10 transmitting said signal light in a deteriorated state of the characteristic of said signal light by that a failure occurred at one of the pumping light sources in said one or more first and second light sources for Raman amplification;

detecting said deterioration state of the characteristic of said
15 signal light by one of said second light sources for Raman amplification; and

recovering said deteriorated state of the characteristic of said signal light to a normal state before deteriorated by emitting spare pumping light from a spare pumping light source disposed in one
20 of said second light sources for Raman amplification.

12. An optical amplification method in an optical transmission system in accordance with claim 11, wherein:

in case that a failure occurred at one of said pumping light sources, said spare pumping light is emitted from said spare pumping
5 light source so that the output level of said signal light becomes the same output level before said failure occurred.

13. An optical amplification method in an optical transmission system in accordance with claim 11, wherein:

in case that a failure occurred at one of said pumping light sources, said spare pumping light is emitted from said spare pumping
5 light source so that the gain wavelength characteristic of said signal light becomes the same gain wavelength characteristic before said

failure occurred.

14. An optical amplification method in an optical transmission system in accordance with claim 11, wherein:

plural pumping light sources emitting plural pumping light of plural wavelengths are used as said pumping light source, and
5 plural spare pumping light sources emitting plural spare pumping light of plural wavelengths corresponding to said plural pumping light sources are used as said spare pumping light source.

15. An optical amplification method in an optical transmission system in accordance with claim 11, wherein:

outputs from said pumping light source and said spare pumping light source are controlled by respective control circuits in
5 said one or more first and second light sources for Raman amplification.